LIBRARY
9 APR 1935
USDA

CIRCULAR No. 334 DECEMBER 1934
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

CHARACTERS USEFUL IN DISTINGUISHING LARVAE OF POPILLIA JAPONICA AND OTHER INTRODUCED SCARABAEIDAE FROM NATIVE SPECIES

By ROBERT J. SIM, *chief illustrator, Division of Japanese and Asiatic Beetles, Bureau of Entomology and Plant Quarantine*

CONTENTS

	Page
Introduction	1
Popillia japonica Newm.	3
Anomala orientalis Waterh.	4
Anomala binotata Gyll.	4
Strigoderma arboricola (Fab.)	4
Pachystethus lucicola (Fab.)	5
Pelidnota punctata (L.)	5
Macrodactylus subspinosus (Fab.)	5
Autoserica castanea Arrow	6
Serica similis Lewis	6
Serica parallela Csy.	6
Diplotaxis sp.	7
Dichelonyx sp.	7
Phyllophaga ephilida (Say)	7
Phyllophaga tristis (Fab.)	8
Polyphylla variolosa (Hentz)	8
Ochrosidia villosa (Burm.)	9
Aphonus castaneus (Melsh.)	9
Xyloryctes satyrus (Fab.)	9
Cotinis nitida (L.)	10
Euphoria inda (L.)	10
Osmoderma eremicola Knoch	10
Aphodius fossor (L.)	11
Tror suberosus (Fab.)	11
Plectris aliena Chapin	12

INTRODUCTION

This circular is intended to present in the simplest way the characters most convenient to use in distinguishing the larvae of *Popillia japonica* and other introduced species from native species which are frequently associated with them. Twenty-four species met with in the eastern part of the United States are briefly described and figured. Special stress is placed upon the epipharyngeal structures and the characters of the tenth or last abdominal segment (posterior end) of the grub.[1] Where expedient, brief notes on the behavior and habitat are given.

For preliminary field determinations involving only general appearance and anal characters, a 10-power hand lens is used. For more careful examination in the laboratory, a low-power binocular microscope is required, together with a watch glass, forceps, and a needle ground to a cutting edge.

The familiar term "white grub" is usually applied to the larvae of May beetles (*Phyllophaga* spp.), but so far as general appearance goes it could be used for any of the scarabaeid species. These may be described as short, more or less stout, blunt-ended grubs of a creamy

[1] In this circular the nomenclature, with the exceptions of raster, sensillae, sclerotized, and sensory eminence, is that given in the following publication: HAYES, W. P. MORPHOLOGY, TAXONOMY, AND BIOLOGY OF LARVAL SCARABAEOIDEA. Ill. Biol. Monographs, v. 12, no. 2. 1929.

82234°—34——1

or whitish color with darker (yellowish or brownish) heads and slight vestiture. Three pairs of short legs are attached to the anterior fourth of the larva on its ventral side. In its usual position—when not crawling—the grub lies curled up in the form of a horseshoe. The surface is more or less shining, but is deeply wrinkled transversely. There are short spines or setae dorsally, and on the end and ventral surface of the terminal posterior segment is a definite arrangement of spines and hairs. This group of spines and setae, as seen from beneath, is called the raster, and offers the most obvious characters for field determinations. At or near the center of this group there are, in many species, a number of dark, stout spines arranged variously as a transverse row, 2 longitudinal rows, or 2 curved or diverging rows. These conspicuously modified spines are, in some species, sufficient for immediate identification without reference to other characters.

The next most useful features are on the head of the grub—the color and "surface finish" of the head capsule and the structures of the epipharynx.

In most species the characters of the head capsule, epipharynx, and raster are sufficient for determination, but in a few the claws may be examined to advantage. In any case, the length and general proportions of a grub should be noted; some species are more slender than others. The normal habitat may be a decaying tree, soil about shrub and tree roots, leaf humus in woodland, the turf of lawns, fields, and pastures, high or low sandy soil, the moist humus of open swamps, etc. Any such distinct condition of environment is generally helpful in making determinations.

The epipharynx is the inner (or under) surface of the labrum, although some of its structures extend back on the inner wall of the clypeus. In order most successfully to examine the epipharyngeal structures, an incision should be made with a very small knife along the clypeal suture which extends transversely between the bases of the mandibles. The entire mass comprising the labrum and clypeus is then turned over and placed in a watch glass of alcohol. If fine particles of foreign matter obscure the structures when the whole is examined under a binocular microscope, they may be removed by careful manipulation of a small pointed brush. For comparison with the drawings, the specimen should be examined with the apex of the labrum pointing away from the observer (the base of the clypeus toward him). Looked at thus, it will be seen that somewhat below the apex there is a raised area or eminence terminating in a sclerotized point or several large fixed spines. This small mound could be called the sensory eminence, for on it are various arrangements of sensillae. These appear as small dark circles, usually in two sizes. At the base of the labrum are two blackish sclerotized plates called the tormae. These extend inward from the sides and may end in acute points or more rarely may be fused with each other, thus forming a narrow dark band across the base of the labrum. The shape of each torma should be noted as a good character in determination. Between the apices of the tormae are several special structures more or less specific in character. At

the apex of the right torma (at left in the drawings) are two rather large sclerotized objects, usually brown in color. These are the sclerotized plate and the sense cone. There may be a few small sensillae and groups of fine sensory hairs near these. Near the apex of the left torma are usually several small sensillae and likewise groups of sensory hairs. In many species there is an elongate group of larger forked sensory hairs above the apex of the left torma.

With the exception of a rather large, concave, smooth median space, the surface of the epipharynx is sparsely armed with articulated spines and hairs. These are largest toward the central space and gradually decrease in size toward the lateral margins of the epipharynx. Just inside each lateral margin there is usually a series of marginal striae.

The entire margin is more or less armed with coarse articulated spines of varying lengths—always greater in the apical region.

As may be seen in the drawings, all the structures are more or less useful in making determinations. Special attention should be paid to the head capsule. Its surface may be glossy or opaque; glabrous, hairy, or setose; smooth, punctured, or reticulated. In color it may be some tone of dull yellow, brown, or blackish. The characters of the head capsule are described in each species. The structures mentioned are shown in the explanatory drawings (fig. 1). The descriptions are by no means complete, as it has seemed undesirable to confuse the observer with discussions of the antennae, mandibles, maxillae, labium, legs, etc. Aside from those of the epipharynx, only the more easily discernible characters are noted. The length measurements given are approximate, having been made as well as possible from alcoholic specimens. The term "form medium" is applied to those species which are neither unusually stout as in *Osmoderma*, nor somewhat slender as in *Macrodactylus*.

POPILLIA JAPONICA NEWM.

(Introduced)

Length 23 mm. Form medium.

Width of head 3 mm.

Surface of head: Smooth, shining. Epicranial stem a fine, dark, impressed line. Epicranial arms not conspicuous. Front with a short, vague, longitudinal, median impression in apical third. At each side of this a row of five punctures diverging toward middle bend of epicranial arm.

Color of head: Pale dull yellow.

Epipharynx (fig. 1): Sensory eminence with a strong, angled sclerotized plate in right side. Several sensillae of two sizes near base of the group of three large, fixed teeth. Right torma long, slender, slightly sinuate; left torma very slender, with apical third curved toward apex of labrum, and with a rather large basal expansion.

Raster (fig. 6): Numerous coarse, rather long, scattered, brown, hooked spines. Medially two conspicuous, divergent rows of shorter, straight spines in V form; 6 or 7 spines in each row. At sides and end of tenth segment numerous rather long, yellowish hairs.

Anal slit: Transverse, arcuate.

Vestiture: Entire grub with rather long scattered brown hairs. Dorsal convexities of first six abdominal segments clothed with fine short brown spines.

Habitat: Soil under turf.

Remarks: The distinct V-like arrangement of short dark spines of the raster are sufficient to identify this species.

ANOMALA ORIENTALIS WATERH.

(Introduced)

Length 25 mm. Form medium.
Width of head 3 mm.
Surface of head: Shining, shallowly reticulated and with several brown setae. Epicranial stem in anterior half a fine impressed line with raised edges. Epicranial arms barely apparent. Front with two paramedian setose punctures near clypeal suture. Two transversely placed setose punctures below middle curve of epicranial arm.
Color of head: Brownish yellow vaguely clouded with brown.
Epipharynx (fig. 2): A vague sclerotized plate on the right below apex of labrum. Sensory eminence with a distinct, wide, arcuate, transverse, sclerotized plate. In the curve of this, several sensillae and 3 or 4 large fixed teeth.
Raster (fig. 6): Subanal convexity with scattered, coarse, rather long, hooked spines. Below this two paramedian rows of very short stout spines, about 14 in each; these rows parallel or slightly divergent at anal end. Outside of these, on each side, two sparse irregular rows of hooked spines smaller than those of subanal convexity. Sides and apex of terminal segment with numerous, rather long, brown hairs.
Anal slit: Transverse, slightly arcuate.
Vestiture: Generally as in *Popillia japonica*, but short dorsal spines slightly more conspicuous.
Habitat: Soil of certain nurseries, lawns, and golf courses.
Remarks: In *Popillia japonica*, *Anomala orientalis*, *A. binotata*, *Pachystethus lucicola*, and *Strigoderma arboricola* the epipharyngeal structures are similar; the slight differences in the sensory eminence, tormae, and sensillae shown in the drawings should be carefully noted.

ANOMALA BINOTATA GYLL.

Length 23 mm. Form as in *Popillia japonica*.
Width of head 3.5 mm.
Surface of head: As in *A. orientalis*, but distinctly and finely reticulate and frontal punctures less apparent.
Color of head: Pale dull yellow vaguely clouded with darker.
Epipharynx (fig. 2): Apparently without sclerotized plate near apex of labrum. The transverse arcuate plate partly encircling the sensillae and four fixed teeth is very narrow.
Raster (fig. 6): Similar to that of *A. orientalis*, but the two paramedian rows of short spines always clearly divergent at anal end.
Anal slit: Transverse, arcuate.
Vestiture: Generally as in *Popillia japonica*, but short dorsal spines slightly finer and closer.
Habitat: Sandy fields and lawns.
Remarks: The reticulate head capsule, the finer frontal punctures, and the definitely divergent lines of spines of the raster characterize this species.

STRIGODERMA ARBORICOLA (Fab.)

Length 23 mm. Form as in *Popillia japonica*.
Width of head 3 mm.
Surface of head: Shining, feebly and finely granulate. Epicranial stem very feebly impressed. Frontal punctures 3 or 4 between clypeal suture and curve of epicranial arm. Front without median impression.
Color of head: Pale dull yellow.
Epipharynx (fig. 2): Generally similar to that of *Anomala orientalis*, but sclerotized plate on right of sensory eminence distinct and smaller. The darkened area including the sensillae of sensory eminence less broad. Apex of left torma longer.
Raster (fig. 6): Similar to that of *Popillia japonica*, but the two paramedian rows of short spines more irregular, longer, and nearly parallel.
Anal slit: Transverse, arcuate.
Vestiture: In general as in *Popillia japonica*.

Habitat: Usually waste, sandy fields and dunes.
Remarks: Difficult to distinguish from some specimens of *Popillia japonica*, but the punctation of the head and the characters of the raster are usually sufficient.

PACHYSTETHUS LUCICOLA (Fab.)

Length 23 mm. Form of *Popillia japonica*.
Width of head 2.5 mm.
Surface of head: Shining, finely reticulate. Occipital half of epicranial stem an impressed line with feebly raised edges. Front uneven; two paramedian setose punctures near clypeal suture; above these, on each side, 2 to 4 transversely placed towards middle curve of epicranial arm.
Color of head: Pale dull yellow.
Epipharynx (fig. 2): Very similar to that of *Strigoderma arboricola*, but sensory hairs of epigusta finer and more numerous. No slender sclerotized plate at right of epigusta.
Raster (fig. 6): Similar of that of *Strigoderma arboricola*, but the two paramedian rows of pointed spines more regular, diverging throughout, with the individual spines longer, eight spines in each row.
Anal slit: Transverse, arcuate.
Vestiture: As in *Popillia japonica*, but small dorsal spines finer.
Habitat: Under turf of pastures, lawns, and fields.
Remarks: This grub is usually yellowish white throughout instead of being darkened by the earthy contents in the ninth and tenth segments. The V of the raster is longer than in *P. japonica* and the two sides are less divergent.

PELIDNOTA PUNCTATA (L.)

Length 40 mm. Form rather stout.
Width of head 6 mm.
Surface of head: Mostly glabrous, faintly glossy, with extremely fine, confused, shallow wrinkles. Epicranial stem narrow, dark, impressed. Epicranial arms very fine, raised. Front rather finely, irregularly punctured anteriorly, the larger punctures with fine yellow setae.
Color of head: A rather bright brownish ocher, darker anteriorly.
Epipharynx (fig. 3): Semicircular in outline. Sensory eminence with a curved sclerotized plate, in center of which is a large short fixed spine. Scattered below plate are several sensillae. Between inner ends of tormae is a short angular chitinous bar; below this, several sensillae. Spines along lateral margins of epipharnyx very short.
Raster (fig. 7): Hairs and spines all rather fine and sparse, of a bright rufous color.
Anal slit: Transverse; sinuate as seen from end of grub.
Vestiture: Dorsal surface of abdominal segments (exclusive of the tenth) with very fine, short, and rather sparse brown hairs interspersed with a few long hairs.
Habitat: The decaying but still firm portions of old stumps, frequently maple and poplar. Usually considerable numbers of these grubs, in various sizes, are found in a single stump.
Remarks: Feeding, as it does, upon decaying wood which is not much discolored, this grub is not usually as dark posteriorly as are most scarabaeid larvae.

MACRODACTYLUS SUBSPINOSUS (Fab.)

Length 15 mm. Form elongate, rather slender.
Width of head 2 mm.
Surface of head: Smooth, shining. Epicranial stem a fine depressed line. Epicranial arms not apparent. Front with six scattered punctures.
Color of head: Dull yellow clouded with rufous.
Epipharynx (fig. 2): With a small apical lobe. Sensory eminence with an oblong sclerotized plate towards the right side. Below this a triangular plate at each end of the row of five sensillae. Four short, blunt, fixed teeth at proximal margin of eminence. The right torma angulately bent at apical third.

Raster (fig. 6): Two paramedian rows of short, stout, well-separated spines, 5 to 7 on each side. Outside of these are widely spaced, heavy, hooked spines about twice as long. On the sides of the terminal segment are a few long scattered hairs. The end is clothed densely with somewhat shorter hairs.
Anal slit: Y-shaped.
Vestiture: Entire grub sparsely clothed with long yellow hairs. Dorsal convexities of first five abdominal segments with numerous short, brown spines.
Habitat: Soil of nurseries, lawns, and fields.
Remarks: The rather slender form and the anal characters distinguish this common grub.

AUTOSERICA CASTANEA ARROW

(Introduced)

Length 15 mm. Form rather slender.
Width of head 2.5 mm.
Surface of head: Shining, mostly glabrous, but with two short, fine setae on each side of vertex, and one in a circular depression just below epicranial branch on each side of front. Epicranial arches very faintly discernible.
Color of head: Pale ocher (dull yellow).
Epipharynx (fig. 4): Curved sclerotized bar below continuous and joining sclerotized plate on right of sensory eminence. Long spines at each side of sensory eminence more numerous and more closely placed. Left torma slender but rather short.
Raster (fig. 6): The transverse curved row of brown spines composed of 18 to 20. The short spines anterior to this (below in drawing) small and numerous.
Anal slit: Longitudinal, forking dorsad.
Vestiture: The first six abdominal segments evenly covered dorsally with very short brownish setae interspersed with a few long fine hairs.
Habitat: Soil of fields, gardens, and lawns of infested areas.
Remarks: This rather slender grub is very active and restless. The very short claw of the leg is characteristic.

SERICA SIMILIS LEWIS

(Introduced)

Length 15 mm. Form rather slender.
Width of head 2 mm.
Surface of head: As in *Autoserica castanea.*
Color of head: As in *A. castanea.*
Epipharynx (fig. 4): Curved sclerotized bar below apex not apparent in the specimens examined. Long spines at each side of sensory eminence large and more numerous than in *S. parallela.* Left torma rather long—longer and more slender than in *A. castanea.*
Raster (fig. 6): Transverse, curved row of brown spines composed of 14 to 18. The short spines anterior to this few in number and very coarse—much fewer and coarser than in *A. castanea.*
Anal slit: As in *A. castanea.*
Vestiture: Similar to that of *A. castanea.*
Habitat: Soil of limited areas on Long Island.
Remarks: Only rather undeveloped third-instar larvae have been available for examination. See remarks under *Serica parallela.*

SERICA PARALLELA CSY.

Length 15 mm. Form somewhat slender.
Width of head 2.3 mm.
Surface of head: As in *Autoserica castanea.*
Color of head: As in *A. castanea.*
Epipharynx (fig. 4): Curved sclerotized bar below apex interrupted at middle. Long spines at each side of sensory eminence few and distant. Left torma short and stout.

Raster (fig. 6): Characters intermediate between those of *A. castanea* and *Serica similis*.
Anal slit: As in *A. castanea*.
Vestiture: Similar to that of *A. castanea*, but the short dorsal setae darker, finer, and slightly less dense.
Habitat: Sandy soil, usually in oak woods and thickets of coastal plains.
Remarks: The three sericine larvae herein described are similar in general characteristics. The slight differences in the epipharynges, rasters, and claws of third legs should be noticed carefully.

DIPLOTAXIS SP.

Length 22 mm. Form somewhat slender.
Width of head 2.5 mm.
Surface of head: Shining, shallowly reticulated. Groove of epicranial stem with narrowly raised edges. Epicranial arms deeply impressed, nearly straight at middle. Front with three large setose punctures on each side—one near middle, one just below middle of epicranial arm, and one near antennal end of epicranial arm.
Color of head: Rather light dull yellow.
Epipharynx (fig. 2): Labrum of the usual suborbicular shape with a vaguely indicated median lobe. Sensory eminence with 6 or 7 larger and 3 smaller sensillae; a rather vague sclerotized plate on right side, and 3 fixed teeth. Right torma long and rather slender; left torma shorter, heavy at base and tapering toward apex. Sense cone and chitinous plate of epigusta small.
Raster (fig. 6): On each side a conspicuous blackish patch of pointed spines, longer and more dense toward anal slit. Lateral and apical hairs of terminal segment rather dense but short.
Anal slit: Y-shaped.
Vestiture: About as in *Popillia japonica*.
Habitat: So far as observed, found in sandy soil.
Remarks: The species shown is from Long Island and is probably *D. atlantis* Fall, which is common there.

DICHELONYX SP.

Length 18 mm. Form slender, as in *Macrodactylus subspinosus*.
Width of head 2 mm.
Surface of head: Shining, slightly or not reticulated. Anterior half of epicranial stem a darkened groove with raised edges. Epicranial arms very slightly impressed. Front with 4 setose punctures—2 paramedian close to clypeal suture and 1 on each side near middle of epicranial arm.
Color of head: Pale dull yellow.
Epipharynx (fig. 2): Outline of labrum somewhat angular; a strong middle lobe with a large convexity on each side; the lateral margins subserrate and with short, coarse spines. Sensory eminence with several sensillae and 2 or 3 large fixed teeth; it is flanked by a vague, oblong sclerotized plate near each side. Tormae nearly meeting above epigusta, their tips obscured by sensory hairs and a large sclerotized plate.
Raster (fig. 6): A median and terminal group of coarse rather long spines, well spaced; at each side an elongate, longitudinal band of very small, short, out-pointing spines. End of terminal segment with a tuft of long hairs at each side.
Anal slit: Y-shaped.
Vestiture: As usual, but inconspicuous.
Habitat: This grub has been found in the soil in nurseries.
Remarks: Easily recognized by the elongate lateral patches of short, small spines of the raster. The species figured is from northern New Jersey and is probably *D. elongata* (Fab.).

PHYLLOPHAGA EPHILIDA (Say)

Length 28 mm. Form medium.
Width of head 3.5 mm.
Surface of head: Opaque, smooth. Epicranial stem a fine, impressed, dark line. Arms not conspicuous. Two very small punctures near each arm on front.

Color of head: Dull yellow.

Epipharynx (fig. 4): Apex obtusely pointed, with margins sinuous. Marginal striae long and distinct. An oblique row of five vague striae near each side of sensory eminence. The eminence has 2 pale sclerotized plates, an arcuate row of 6 large sensillae, and an irregular group of dark fixed teeth. Between and below the tormae are many sensillae and sensory hairs.

Raster (fig. 6): Two long nearly parallel rows of small, short spines. Outside of these, numerous much longer, brown, hooked spines merging into still longer, fine yellow hairs at sides and apex. The small paramedian spines are not closely placed, and the two rows converge slightly toward the anal end.

Anal slit: Broadly Y-shaped.

Vestiture: A few scattered long pale hairs throughout. Dorsal convexities of first six abdominal segments with fine, pale, inconspicuous, evenly spaced spines.

Habitat: Soil under turf in pastures, lawns, etc.

Remarks: Of the numerous *Phyllophaga* species, this and *tristis* are the only ones that have been reared at Moorestown, N. J.

PHYLLOPHAGA TRISTIS (Fab.)

Length 25 mm. Form medium.

Width of head 3.5 mm.

Surface of head: Opaque, smooth. Epicranial stem a fine dark line impressed in anterior half. Arms not conspicuous. Front with a distinct subcircular impression at each side of middle near clypeal suture and two small punctures below middle of epicranial arm.

Color of head: Light brownish yellow.

Epipharynx (fig. 4): Similar to that of *P. ephilida*, but without submarginal striae, with only one sclerotized plate (right) in sensory eminence, and fewer sensillae on epigusta.

Raster (fig. 6): Two well-separated, arcuate rows of short brown spines. Outside of these a few longer, scattered, hooked spines. Sides of terminal segment with sparse, rather long brown hairs, those of apex somewhat shorter.

Anal slit: A broad Y.

Vestiture: Practically as in *ephilida*.

Habitat: Soil under turf of lawns, pastures, and open grassy spots in woodland.

Remarks: The two paramedian rows of spines of the raster resemble parentheses. These are distinctive. While the epipharynges of most *Phyllophaga* grubs have submarginal striae, no trace of these could be detected in the several *tristis* specimens available.

POLYPHYLLA VARIOLOSA (Hentz)

Length 40 mm. Form medium.

Width of head 6 mm.

Surface of head: Opaque because of fine reticulation. Anterior part of front more distinctly roughened. Epicranial stem impressed, the anterior third with raised margins. Epicranial arms scarcely apparent. Three seta-bearing punctures on each side of front. Clypeus and labrum rough.

Color of head: Yellowish brown with two vague, longitudinal, lighter bands.

Epipharynx (fig. 5): To the right of the group of fixed spines on the sensory eminence are a dozen or more small articulated spines. The right side of the median bare area is bordered with numerous fine hairs. There are no submarginal striae.

Raster (fig. 7): Numerous short hooked spines, with a short, distinct, double row of short straight spines medially. Each side densely clothed with longer brown hairs.

Anal slit: Transverse, clearly sinuate.

Vestiture: First five abdominal segments dorsally clothed rather densely and evenly with short brown setae. Sides glabrous, venter with numerous rather long brown hairs.

Habitat: Sandy soil of the east coast States. These larvae feed upon plant roots, are sometimes found in the turf of golf courses, and have been known to kill privet hedge and small maple trees.
Remarks: Distinguished from similar sized *Phyllophaga* grubs by the short but dense brown vestiture of the back and the short double row of spines in the center of the raster.

OCHROSIDIA VILLOSA (Burm.)

Length 24 mm. Form medium or slightly stout.
Width of head 4 mm.
Surface of head: Shining, shallowly but sharply reticulate. Upper part of epicranial stem a fine impressed line with broadly swollen margins. Front with a large roundish impression at each side of middle, each with a setose puncture; a transverse row of three small punctures above and outside these impressions. Rather numerous small punctures near clypeal suture.
Color of head: Brownish yellow clouded with darker.
Epipharynx (fig. 4): Sensory eminence with a single large, dark, sclerotized plate with a rounded apex, in the left side of which is a deep notch. The sense cone on the epigusta is rather small.
Raster (fig. 7): A sparse group of coarse, long, hooked brown spines becoming larger towards anal slit. Apex of terminal segment somewhat truncate and clothed with yellow hairs of moderate length.
Anal slit: Transverse, arcuate.
Vestiture: Normal, i.e., a general very sparse distribution of long slender hairs, and rather densely placed, very short brown dorsal spines.
Habitat: Common and often harmful in the turf of lawns and golf courses.
Remarks: Slightly larger and stouter than the *Popillia* grub and may be distinguished from it in the field by lack of V in the raster.

APHONUS CASTANEUS (Melsh.)

Length 28 mm. Form rather stout.
Width of head 3.5 mm.
Surface of head: Shining, but (except at extreme sides) hairy and roughened, with rather close and coarse setose punctures. Epicranial stem a distinct impressed line. Epicranial arms obscured by the general punctation.
Color of head: Chestnut brown, slightly lighter at sides.
Epipharynx (fig. 4): Sensory eminence with a single large, dark, sclerotized plate. The apex comes to a broadly obtuse point directed towards the large median spineless area. On the right margin a single large articulate tooth. Sense cone on epigusta large and elongate.
Raster (fig. 7): An extensive patch of brown, hooked spines, similar to that of *Ochrosidia villosa* but with the spines more numerous and noticeably smaller. End of abdomen rounded—not slightly truncate as in *Ochrosidia*.
Anal slit: Distinctly arcuate.
Vestiture: Fairly numerous long hairs throughout; the small dorsal spines more hairlike and longer than usual.
Habitat: Sandy soil. Rather frequent in turf of golf courses of the coastal plains.
Remarks: The dark, rough, hairy head immediately distinguishes this grub from any others herein described.

XYLORYCTES SATYRUS (Fab.)

Length 55 mm. Form stout.
Width of head 7 mm.
Surface of head: Shining, glabrous, coarsely punctured throughout, vaguely impressed on each side of front. Epicranial stem impressed at top of vertex.
Color of head: Brownish black.
Epipharynx (fig. 5): The striking characters are the large blunt beaklike sclerotized projection of the sensory eminence and the T-shaped apex of the left torma.
Raster (fig. 7): As shown, without special structures.

Anal slit: Transverse, slightly sinuate at ends.
Vestiture: Surface mostly glabrous; first five abdominal segments dorsally with very short, sparse, dark-brown spines, interspersed with very few long brown hairs.
Habitat: The humus under dead leaf carpet of deciduous woods. Usually 2 or 3 grubs may be found within 3 square yards.
Remarks: The prothoracic sclerotized plate is rufous brown and conspicuous. The large distinct spiracles are darker brown. This is the largest of the northern scarabaeid grubs.

COTINIS NITIDA (L.)

Length 38 mm. Form rather stout, blunt, flattened beneath.
Width of head 5 mm.
Surface of head: Mostly glabrous, feebly shining, finely roughened with irregular, impressed reticulation. Epicranial stem and arms showing distinctly as impressed light lines, the former seeming to continue downward as a median furrow in upper half of front. Surface of front irregular; a large puncture or pit below the middle of each epicranial arm.
Color of head: Chestnut brown, blackish near clypeal suture.
Epipharynx (fig. 3): Three-lobed; the marginal depression each side of median lobe with a small darkish mark. Sensory eminence not pronounced. About 12 short, fixed spines in a strongly curved transverse row. No distinct sclerotized plate in median lobe. Right torma extended basally, below.
Raster (fig. 7): Numerous fine hairs of medium length, becoming longer at the sides and end of the terminal segment. Medially a rather long double row of very short, stout spines quite irregularly placed.
Anal slit: Short, broadly arcuate.
Vestiture: Practically the entire grub clothed rather evenly, but inconspicuously, with fine brown hairs, those on the dorsal surface much shorter than the hairs of the venter.
Habitat: In soil under manure or decaying vegetation in open places.
Remarks: This grub, like most of the Cetoniinae, is a "back-crawler." The prothoracic sclerotized plates are rather large, well defined, yellowish brown. The legs are short and brownish yellow.

EUPHORIA INDA (L.)

Length 35 mm. Form short, stout, blunt.
Width of head 4 mm.
Surface of head: Mostly glabrous, shining, very feebly reticulate. Furrow of epicranial stem extending downward on front between arms. A large puncture just below middle bend of epicranial arm on each side of front.
Color of head: Brownish yellow.
Epipharynx (fig. 3): Similar to that of *Cotinis*, but with a long, narrow, curved, rather feeble sclerotized plate above the row of fixed spines of the sensory eminence. A definite but thin sclerotized plate above sense cone. Few, if any, spines below apex of left torma.
Raster (fig. 7): Similar to that of *Cotinis*, but vestiture more sparse and without any special median spines.
Anal slit: Transverse, nearly straight.
Vestiture: Very slight, limited to a narrow band of fine, short, stiff hairs (1 or 2 hairs wide) on each convex fold; those of the dorsal surface very short, the very sparse lateral and ventral hairs much longer.
Habitat: Usually in and under old horse manure.
Remarks: A "back-crawler." One favored habitat is the old mixed sawdust and horse manure about an abandoned sawmill in the woods.

OSMODERMA EREMICOLA KNOCH

Length 45 mm. Form stout, distinctly larger posteriorly and blunt at the ends.
Width of head 6.5 mm.
Surface of head: Nearly glabrous; rather shallowly, irregularly, but distinctly reticulated. Epicranial stem dark and deeply impressed. Epicranial arms showing distinctly as narrow light-yellow lines. Front irregularly roughened. Mandibles short, stout, and very irregular in surface.

Color of head: Vertex yellowish brown; front darker brown.
Epipharynx (fig. 3): Three lobed, the depression in the outline at each side of median lobe with a small dark mark. The sensory eminence not pronounced but broad and with a slightly curved transverse row of about 12 short fixed spines. Above this are several small sensillae. An elongated sclerotized plate in the right side of the median lobe.
Raster (fig. 7): A large area of sparse, very short blackish spines medially, rather numerous but scattered longish dark hairs laterally and apically.
Anal slit: Transverse, arcuate.
Vestiture: Entire surface very sparsely clothed with fine but stiff dark-brown hairs, short to medium in length. This vestiture noticeable to the touch but not conspicuous to the naked eye.
Habitat: The much-decayed interior of dying tree trunks. Frequently many of varying sizes are found in one tree.
Remarks: The prothoracic sclerotized plates are large, sharply defined, and yellowish brown; the spiracles, dark brown.

APHODIUS FOSSOR (L.)

Length 10 mm. Form short, stout, dilated posteriorly.
Width of head 3 mm.
Surface of head: Opaque, very finely closely reticulated. Epicranial stem impressed, margins raised in anterior third. Front with longitudinal furrow in upper fourth: a vague vertical depression on each side just above clypeal suture.
Color of head: Rather dark bright brown.
Epipharynx (fig. 3): Definitely three-lobed. Sensory eminence with a long transverse line of minute sensillae, below which is a semicircle of short toothlike spines continuing laterally to base of labrum. Central bare area with a tuft of fine hairs above and to right of middle, which has a dark line extending from base. A band of fine hairs between apices of the short tormae.
Raster (fig. 6): Numerous very short, stout blackish spines rather evenly placed. On each side a few slender hairs.
Anal slit: Transverse, arcuate; three glabrous swellings below.
Vestiture: Mostly glabrous; a few scattered pale hairs dorsally.
Habitat: Fresh cow manure in pastures.
Remarks: The brown head, the three bare swellings at posterior end of grub, and the epipharyngeal characters distinguish this (the largest) aphodian larva.

TROX SUBEROSUS (Fab.)

Length 18 mm. Form elongate, slightly tapering posteriorly.
Width of head 3.8 mm.
Surface of head: Shining, rather coarsely but vaguely reticulate. Epicranial stem a sharp narrow groove with raised edges. Epicranial arms impressed. Anterior half of front with two vague longitudinal impressions near middle.
Color of head: Very deep chestnut brown.
Epipharynx (fig. 3): Two-lobed. Arrangement of structures almost bilaterally symmetrical. Details sufficiently shown in drawing.
Raster (fig. 6): An irregular transverse band, medially interrupted, of sparse, blackish hairs.
Anal slit: Y-shaped; on each side a glabrous swelling with a fine black line on it.
Vestiture: Each dorsal convexity of first six abdominal segments with a single row of close, short, erect blackish spines. Entire grub with scattered dark hairs, longest beneath.
Habitat: Soil under piles of old feathers, hair, or night soil.
Remarks: Together with the typical habitat, the peculiar epipharyngeal and anal characters should make this grub easy to identify. Each larva lives in a vertical burrow down which he drags a wad of food material for immediate needs.

PLECTRIS ALIENA (Chapin)

Length 28 mm. Form medium.

Width of head 3.5 mm.

Surface of head: Shining, rather coarsely, shallowly reticulate. Epicranial stem a narrow impressed line through a slight swelling. Postclypeal margin of front with numerous fine punctures; above these two paramedian pits; below curve of epicranial arm one large setose puncture and several minute ones. Epicranial arms finely impressed.

Color of head: Dull yellow.

Epipharynx (fig. 8): Outline of labrum very angular, margins irregular. Marginal spines coarse. Marginal striae distinct, long, sinuous and sometimes interrupted. Sensory eminence with numerous large and small sensillae arranged in a transverse arcuate line. Five large fixed teeth. Sensory hairs near tormae numerous and coarse. Tormae short and stout.

Raster (fig. 8): Straight, pointed spines arranged in a large, spreading V made up of 1 to 3 ranks of the inward-pointing spines. Outside of this about 3 irregular rows of larger, outward-pointing hooked spines. End and sides of terminal segment with many rather long brown hairs, the former with interspersed short stout spines.

Anal slit: Transverse, V-shaped.

Vestiture: A few scattered long hairs over entire surface of grub. The usual small brown dorsal setae rather dense and conspicuous.

Habitat: Turf of golf courses, etc.

Remarks: A species of probably South American origin now found in the South Atlantic States. While generally resembling common white grubs, this larva is very different in details of structure, as shown in the drawings.

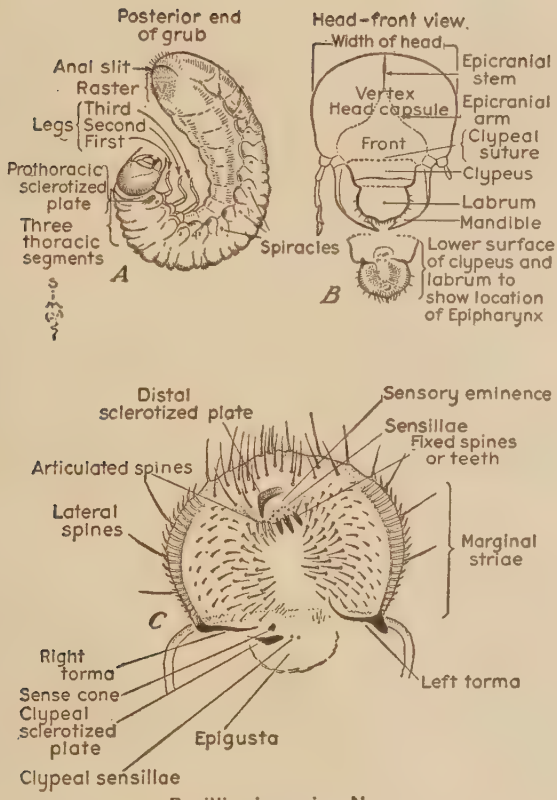

FIGURE 1.—*A*, diagram of a scarabaeid larva; *B*, diagram of head of a scarabaeid larva; *C*, epipharynx of *Popillia japonica*.

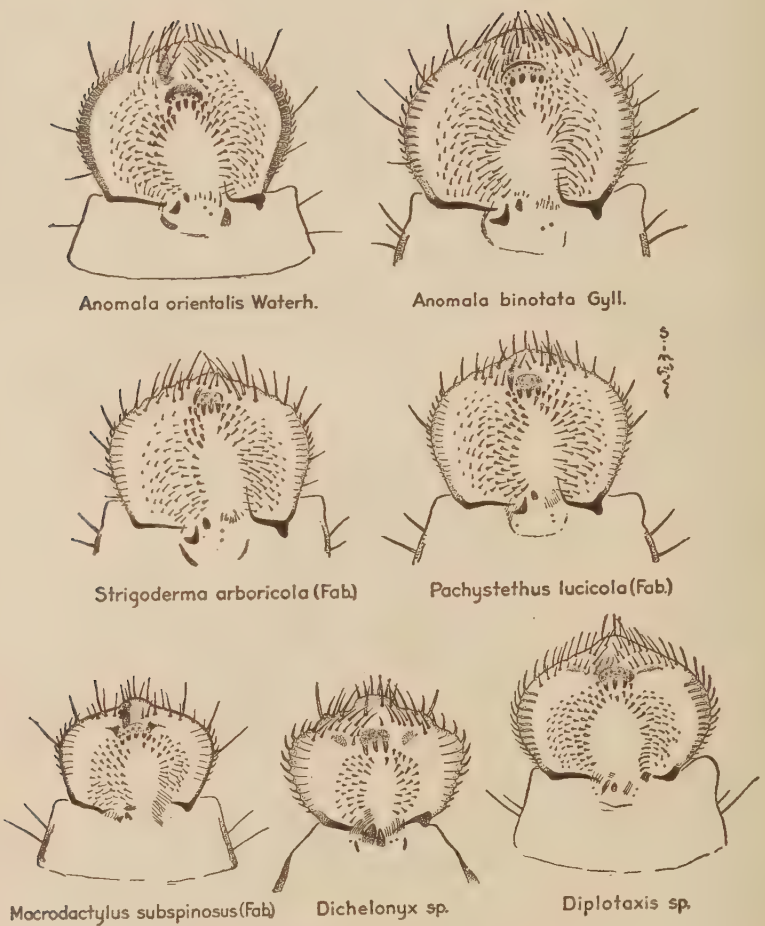

FIGURE 2.—Epipharynges of scarabaeid larvae.

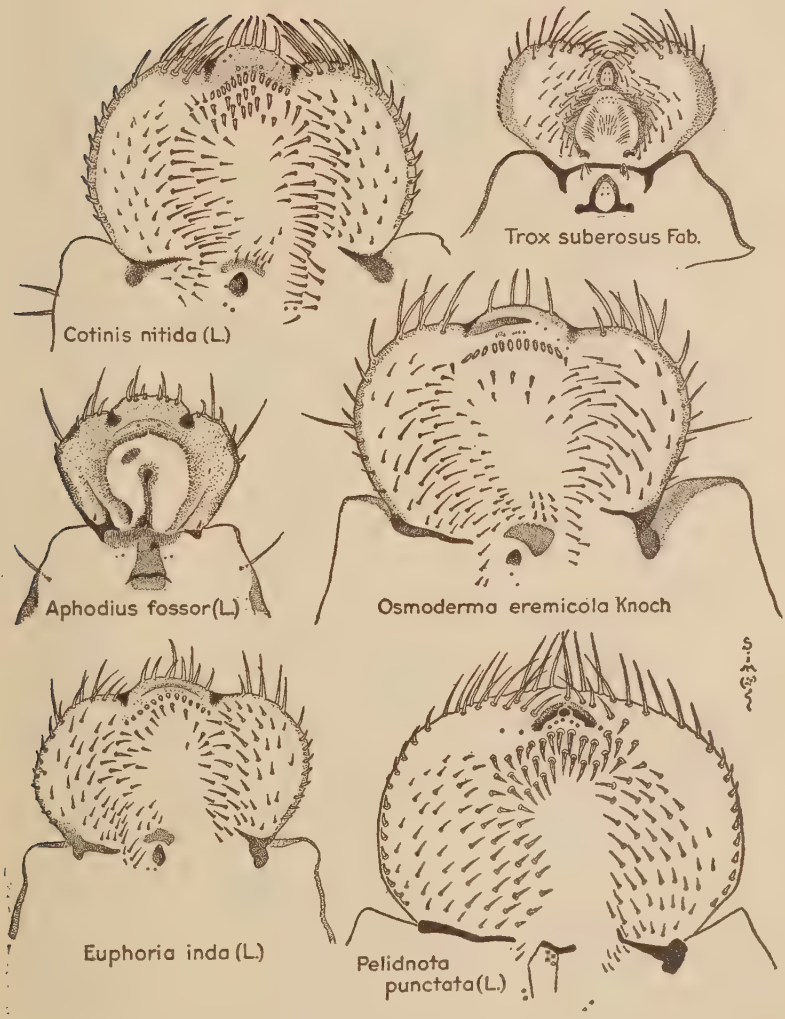

FIGURE 3.—Epipharynges of scarabaeid larvae.

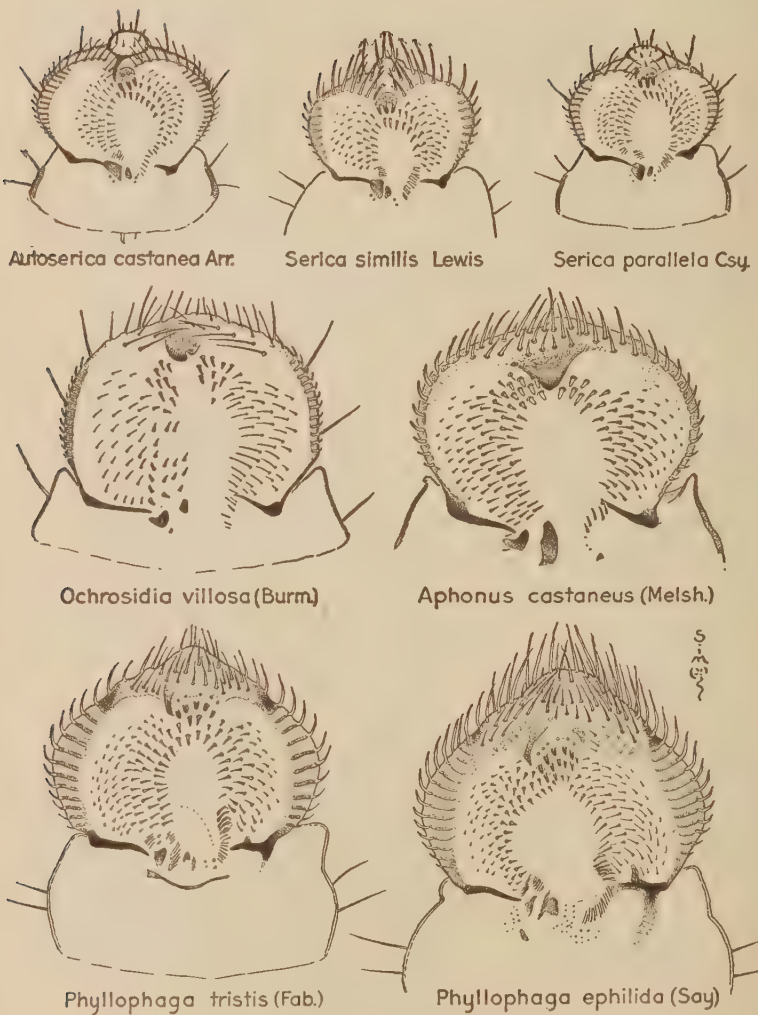

FIGURE 4.—Epipharynges of scarabaeid larvae.

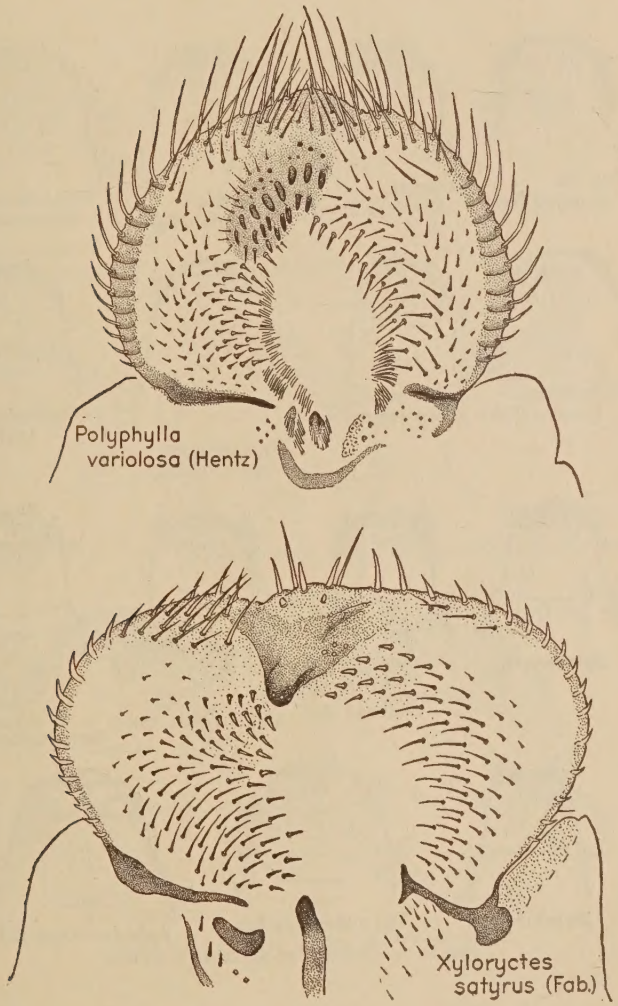

FIGURE 5.—Epipharynges of scarabaeid larvae.

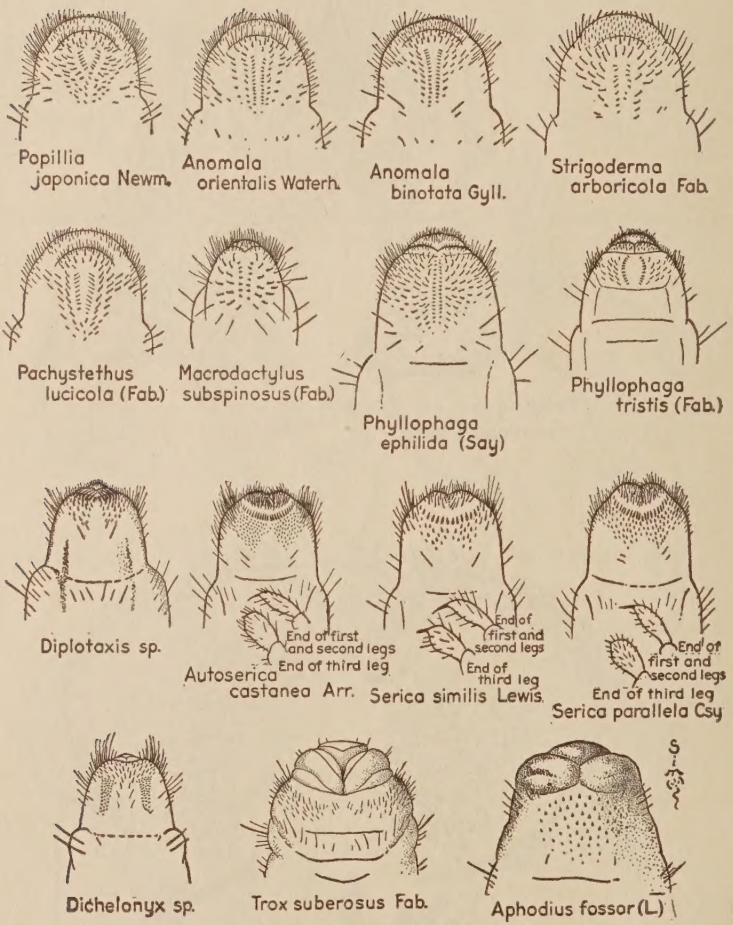

FIGURE 6.—Rasters of scarabaeid larvae.

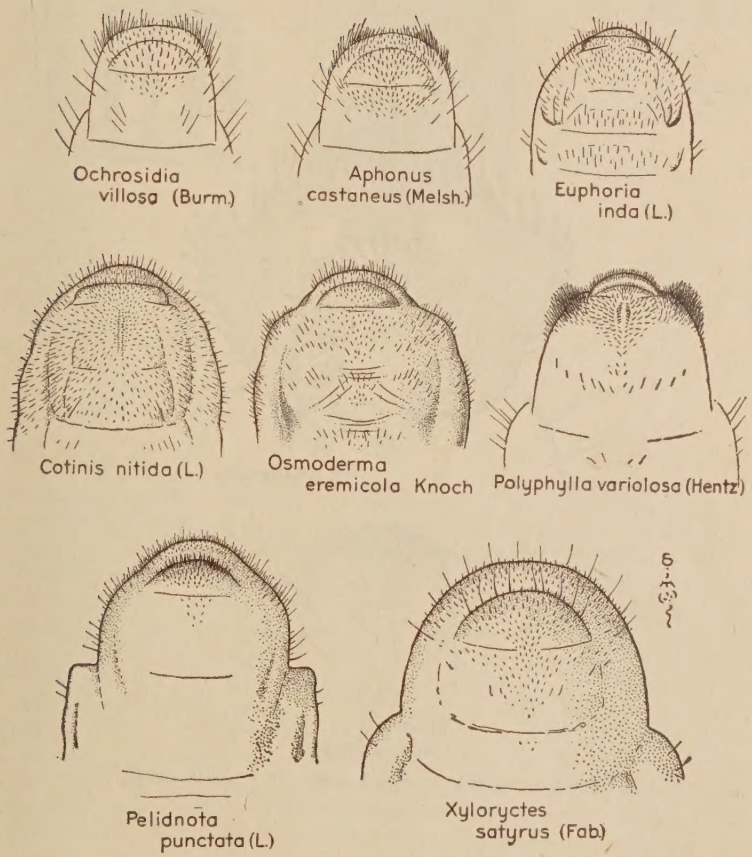

FIGURE 7.—Rasters of scarabaeid larvae.

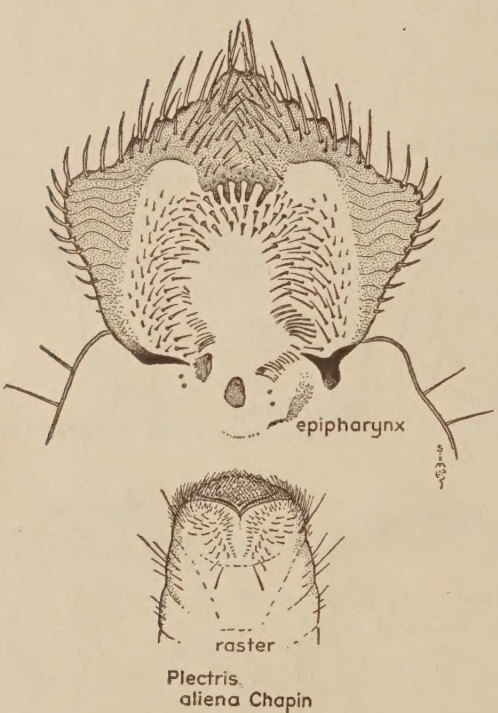

FIGURE 8.—Epipharynx and raster of *Plectris aliena*.

U. S. GOVERNMENT PRINTING OFFICE: 1934

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents